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rod or plank laid between the foot of the bar and an opposite wall. Now let a rope be passed from the foot of the bar over a pulley. What weight attached to the rope will relieve the floor of all pressure?

By the Law of Virtual Velocities, Power and Weight are inversely proportioned to their rates of movement in the direction required. In the present case these rates are obviously equal, and the power must equal the weight. Hence the pressure on the floor will be 2000 lbs. for all positions of the bar.

For the pressure on the wall, suppose the bar inclined 30° from the vertical. Its whole weight may be considered concentrated in its center of gravity. Its tendency to move is in an arc whose radius is 10. But only the vertical part of this movement is effective, and this part is expressed by sin30°.

This supposed movement of the center of the bar implies a movement of the upper end in an arc whose radius is 20. But we are concerned only with the horizontal part of this movement and this is expressed by cos 30°. Hence, by the law before quoted, Power (2000 lbs): Weight :: 2cos 30° : sin 30°. (*Twice* cos 30° because R is double).

$$\therefore \text{ Weight or pressure on wall} = \frac{2000 \times \sin 30^\circ}{2 \cos 30^\circ} = 1000 \times \tan 30^\circ.$$

In general the pressure on the wall equals half the weight of the bar multiplied by the tangent of the inclination.

At 30° A is $577\tfrac{35}{100}$ lbs.
At 45° A is 1000 lbs.
At 80° A is $5671\tfrac{28}{100}$ lbs.

This problem was also solved by *P. S. Berg and J. F. W. Scheffer.*

17. **Proposed by WILLIAM HOOVER, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.**

Find the law of density of strings collected into a heap at the edge of a table with the end of the string just over the edge, so that equal masses may always pass over in equal units of times.

Solution by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

A pulverized solid, if piled up, will settle by the force of gravity, to a certain inclination, according to the smallness and smoothness of its particles. Now, a string is practically a cylindric solid of *great* length, *small* cross-sections, and *indefinite* flexibility and compresibility. In passing over the edge of the table, the string will pile into an *approximate* right circular cone. A stream of pulverized solid—an *impalpable powder*, like precipitated B_aSO_4—is practically a *string* of indefinitely small molecular attraction; and such a string will pile into a right circular cone.

Let $AO=r_1$, $CI=m_1$, $\angle CAO=\omega_1$ and δ_0=the initial density of the first *string-cone* formed. Pass a pound (W_1) of string *uniformly* over the edge of the table; then from the cone $AOB-C$, we have

$$W_1=M_1g=V_1\delta_0,=\tfrac{1}{3}\pi r_1^3\delta_0 g\tan\omega_1 \ldots .(1).$$

Pass similarly a second pound of string; then will be formed the cone

$A'OB'-C'$,and the cone $AOB-C$ will be compressed into the cone $AOB-I$.

The volume of the *compressed* string-cone, $AOB-I$, becomes

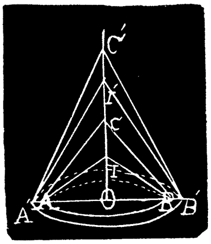
$W_1=M_1g=V_1\delta_1g,=\frac{1}{3}\pi r_1^2(r_1\tan\omega_1-m_1)\delta_1g\ldots.(2).$

Equating the right-hand members of (1) and (2), we have

$$\delta_1=\left(\frac{r_1\tan\omega_1}{r_1\tan\omega_1-m_1}\right)\delta_0,\ldots.,\delta_n=\left(\frac{r_1\tan\omega_1}{r_1\tan\omega_1-m_n}\right)$$

$\delta_1\ldots.(3).$

The values of $\delta_1\ldots.\delta_n$, as determined empirically for determinate conditions, immediately lead to the required law of density.



18. Proposed by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University, Mississippi.

An elleptic paraboloid whose equations is $\frac{y^2}{a}+\frac{x^2}{b}=2z$ has its axis vertical and vertex downward. If μ be the co-efficient of friction, prove that a heavy particle will rest at any point of the surface below its intersection with the cylinder $\frac{y^2}{a^2}+\frac{x^2}{b^2}=\mu^2$.

Solution by the PROPOSER.

If W is the weight of the particle, N and T its normal and tangential components, $W^2=N^2+T^2$. Also, when the particle is on the point of sliding, $T=\mu N$. Hence, $W^2=(1+\mu^2)N^2$. Again, $W\cos\theta=N$, θ being the angle between the normal and the Z–axis.

Now $\cos\theta=\dfrac{\frac{dF}{dz}}{\sqrt{\left(\frac{dF}{dx}\right)^2+\left(\frac{dF}{dy}\right)^2+\left(\frac{dF}{dz}\right)^2}}$, $F(x,y,z)=0$ being the equation of the surface, and the differential-coefficients being partial.

$\frac{dF}{dx}=\frac{2x}{b},\frac{dF}{dy}=\frac{2y}{a},\frac{dF}{dz}=-2.$ Substituting, $\cos\theta=\dfrac{-2}{\sqrt{\left(\frac{4x^2}{b^2}+\frac{4y^2}{a^2}+4\right)}}$.

This, in the fourth equation above, gives, after squaring,

$N^2=\dfrac{4W^2}{\frac{4x^2}{b^2}+\frac{4y^2}{a^2}+4}$. Substituting this value of N^2 in the third equation and reducing we get $\frac{y^2}{a^2}+\frac{x^2}{b^2}=\mu^2$.

This is the relation between the x and y co-ordinates of every point of the surface at which the friction is limiting; in other words, these points lie on the cylindrical surface of which this is the equation. Consequently, their locus